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Human Stress Level Detection and Monitoring System

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ABSTRACT

Certain amount of stress is necessary for our lives, but too much stress brings negative consequences such as decreases in level of concentration, mental health issues such as anxiety and depression as well as ineffective ways of coping, such as substance abuse. Most people do not know when and what situations they get stress from. The detection of emotional states, and brain attentiveness levels are increasingly becoming an important field for human-computer interaction as we find more ways to benefit and advance with this data. Emotion recognition can be achieved by many different methods. Currently, heart rate, skin conductivity, voice recognition, and body temperatures are means of collecting data. One of the methods this research paper explores is successful means of detecting emotion or attentiveness through brain-computer interfaces (BCI) using electro- encephalography (EEG).

Keywords: Human stress, Heart rate sensor, Neuro-sky sensor, Wi-Fi module, GSM module.

1. INTRODUCTION

Stress is a physiological condition or a mentally disabled condition in which body becomes excited to face an emergency situation. A number of physiological changes such as heart rate, breathing rate, decrease in level of concentration occurs during high stress state. There are also continuous stress detection devices, such as stress dots but they don't provide the user with a way of relieving their momentary stress. It is our intention to address these gaps in the market and create a system that will be of benefits to a great many patients and health care practitioners by better assisting them by taking control of an elevated physiological response that has many negative health consequence.

Generally, it is near impossible to detect one's true emotion. In this moment in time, there are sensors to detect heart rate, skin conductivity, voice recognition, and body temperatures. These are all means of collecting data in order to aid in sensing emotion. By far, the more accurate sensors are ones that detects brain activity, for example, EEG. The brain is made up of billions of brain cells which use electricity to communicate with each other. The combination of millions of neurons sending signals at once produces an enormous amount of electrical activity in the brain, which can be detected using sensitive medical equipment to measure electricity levels over areas of the scalp.

EEG's are recordings of the electrical activity along the scalp. It measures voltage fluctuations resulting from ionic current flows within the neurons of the brain. Whether students are attentive when learning significantly influences their learning outcomes. In traditional face-to-face instruction, teachers generally observe student's expressions to determine whether they are sufficiently attentive. However, this method is excessively subjective and consumes a significant amount of the teacher's energy. Furthermore, besides face-to-face instruction, students may engage in distance learning over the Internet, which further increases the difficulty of determining whether students are attentive. In all circumstances,

the neurons in the human brain are ceaselessly active, emitting small amounts of electromagnetic waves. These electromagnetic waves are used as EEG signals.

During the learning process, whether students remain attentive throughout instruction generally influences the efficiency in their learning abilities. If teachers can instantly identify whether students are attentive they can be suitably reminded to remain focused, thereby improving their learning effects.

2. BACKGROUND

2.1 Overview of background

The human brain is made up of billions of interconnected neurons the patterns of interaction between these neurons are represented as thoughts and emotional states. Every interaction between neurons creates a minuscule electrical discharge; alone these charges are impossible to measure from outside the skull. However, the activity created by hundreds of thousands concurrent discharges aggregates into waves which can be measured. Different brain states are the result of different patterns of neural interaction. These patterns lead to waves characterized by different amplitudes and frequencies; for example waves between 12 and 30 hertz, Beta Waves, are associated with concentration while waves between 8 and 12 hertz, Alpha Waves, are associated with relaxation and a state of mental calm. (The contraction of muscles is also associated with unique wave patterns, isolating these patterns is how some NeuroSky devices detect blinks.)

All electrical activity produces these waves (even light bulbs), thus all electrical devices create some level of ambient “noise”; this “noise” interferes with the waves emanating from the brain, this is why most EEG devices will pick up readings even if they are not on a person’s head. Measuring mental activity through these waves is like trying to eavesdrop on a conversation at a loud concert. In the past, EEG devices circumvented this problem by measuring these signals in environments where electrical activity is strictly controlled and increasing the signal strength of the data coming from the brain through the application of a conductive solution.

2.2 Neurosky sensor

Neurosky sensor is used to find electrical activity of neurons existing in the human nervous system. The device consists of a headset, an ear chip and a sensor arm. The headset reference and ground on the ear chip and EEG electrode is on the sensor arm, resting on the forehead above the eye position. This is the sensor’s which senses the brain wave that is alpha or beta waves and transmit it to microcontroller via bluetooth to detect the stress produced by user and this is displayed on GLCD display.

Below are the different levels of brain waves and what they could mean about a person's Emotional state:

• Alpha: 8 – 13Hz: This type of periodic wave is produced in the parietal and occipital regions of the brain when in a state of consciousness, quiet, or at rest. When thinking, blinking, or otherwise stimulated, waves disappear. This is known as an alpha block.

• Beta: 14 – 30Hz: This type of activity occurs in the frontal region when people are conscious and alert. These waves are particularly apparent when a person is thinking or receiving sensory stimulation.

• Theta: 4 - 7Hz: This activity primarily occurs in the parietal and temporal regions of the brain. Such waves are produced when people experience emotional pressure, interruptions of consciousness, or deep physical relaxation.

• Delta: 0.5 - 3Hz: In a conscious state, most adults exhibit almost no delta activity; instead, this activity occurs when in a deep sleep, unconscious, anesthetized, or lacking oxygen.

• Gamma: 5 – 10Hz: Recent studies have found that gamma activity is related to selective attention. Other studies have also highlighted that this activity is related to cognition and perceptual activity.

2.3 Heart rate sensor

Heart rate sensor is used to detect the heart beat rate per minute from human cardiac system.this device consists of wrist wear sensor and the reciever in which the heart rate sensed and transmit to the controller. This controller produces the output for heart rate. For every 5 count of heart beat is sensed continuosly within the 2 seconds by

sensor the receiver should receive it otherwise the sensing will be restarted. Then if the controller senses correctly the heart rate will be seen on GLCD display to know exactly how much does the user have if the stress is present or not.

2.4 GLCD Display

A graphic LCD (liquid crystal display) is an electronic visual display technology used in different gadgets and information-output sources, mostly in display screens of electronic devices. This technology employs manipulating tiny crystals of a contained liquid crystal solution through precise electronic signals to perform graphic display operations over a two-dimensional physical screen. LCD technology is considered the successor of conventional CRT (cathode ray tube) visual display technology, which uses electron-firing gun to produce a pixel-based display over monitor screens. LCDs are thin and compact visual display units, having a very closely integrated structural assembly. In its normal design, a graphic LCD is comprised of five basic layers arranged in parallel to each other.

The most common application of LCD is found in cell phones screens, laptop computer screens, LCD monitors, calculators, digital readers, electronic diaries and watches, flat-screen televisions, and many other electronic devices or gadgets that display information in visual or text-based format. Moreover, significant advancements into the design and operational assembly of LCDs have made it possible to be used as device capable of both input and output operations. Graphic LCDs offer multiple significant advantages over traditional CRT-based visual display units Furthermore, all these features have considerably contributed towards integration of these visual display units into commercial portable electronic items.

2.5 Bluetooth module

HC-05 embedded Bluetooth serial communication module (can be short for module) has two work modes: order-response work mode and automatic connection work mode. And there are three work roles (Master, Slave and Loopback) at the automatic connection work mode. When the module is at the automatic connection work mode, it will follow the default way set lastly to transmit the data automatically. When the module is at the order-response work mode, user can send the AT command to the module to set the control parameters and sent control order. The work mode of module can be switched by controlling the module PIN (PIO11) input level.

2.6 GSM module

GSM is a cellular network, which means that cell phones connect to it by searching for cells in the immediate vicinity. GSM (Global System for Mobile) / GPRS (General Packet Radio Service) TTL -Modem is SIM900 Quad-band GSM / GPRS device, works on frequencies 850 MHZ, 900 MHZ, 1800 MHZ and 1900 MHZ. It is very compact in size and easy to use as plug in GSM Modem. The Modem is designed with 3V3 and 5V DC TTL interfacing circuitry, which allows User to directly interface with 5V Microcontrollers (PIC, AVR, Arduino, 8051, etc.) as well as 3V3 Microcontrollers (ARM, ARM Cortex XX, etc.). The baud rate can be configurable from 9600-115200 bps through AT (Attention) commands. This GSM/GPRS TTL Modem has internal TCP/IP stack to enable User to connect with internet through GPRS feature. It is suitable for SMS as well as DATA transfer application in mobile phone to mobile phone interface. The modem can be interfaced with a Microcontroller using USART (Universal Synchronous Asynchronous Receiver and Transmitter) feature (serial communication).

2.7 Wi-Fi module (ESP8266)

ESCP8266 is a set of high performance, high integration wireless SOCs, designed for space and power constrained mobile platform designers. It provides unsurpassed ability to embed Wi-Fi capabilities within other systems, or to function as a standalone application, with the lowest cost, and minimal space requirement. ESP8266EX offers a complete and self-contained Wi-Fi networking solution; it can be used to host the application or to offload Wi-Fi networking functions from another application processor. When ESP8266EX hosts the application, it boots up directly from an external flash. In has integrated cache to improve the performance of the system in such applications.

2.8 Atmega328 microcontroller

The ATMEGA 328 is a low-power, high performance, 8-bit RISC-based AVR microcontroller that combines 32KB ISP flash memory with read while write capabilities. The device is manufactured using Atmel's high density non-volatile memory technology and is a compatible with the industry standard and pin out. The on chip flash allows the program memory to be reprogrammed in system or by a conventional non-volatile memory.

3. METHODOLOGY AND IMPLEMENTATION

In this work, two types of sensors are used namely heart rate and brain wave sensor. Neurosky sensor detects the brain waves and indicates the stress including attention and meditation levels. This project prefer to use Atmega 328 microcontroller as it is user friendly, lower cost and stable of accuracy. For heart rate, the tool to detect it also known as chest strap heart rate sensor is capable to detect the electrical activity of heart rate by attaching at chest. It is exactly pumping blood flow through the body, while heart is beating cause the blood volume in the body artery to vary also. The signal can be analyzed further for the microcontroller to calculate the heart rate. Figure xx shows the proposed scheme for this work. Pluguino board is connected to the GLCD to show the output of the system as shown in figure 1. After captured the signal using heart rate sensor and neurosky sensor, the data will be processed by the controller. The controller works with C programming and for this project there are three parts of coding which include heart rate sensor, neurosky sensor and GLCD. GLCD is used to display the result. SD Card Breakout is used to store the results of the heart rate and Neuro sky sensor got at different times. Heart rate sensor easures the heart beat rate. Neuro sky sensor measures the electrical activity of the neurons in the brain. Depending on the values of sensors stress level is measured, such as concentration level and attention level.

4. RESULTS AND ANALYSIS

From the Arduino system, the results are obtained and important information including heart rate, stress level which is the output of the system. To make the project more real application the information is displayed on GLCD. It also can be displayed on PC by using Arduino software monitor as shown in figure 2, the values obtained by neurosky sensors are showed in figure 3 and the heart rate and stress level is displayed on glcd as shown in figure 4.

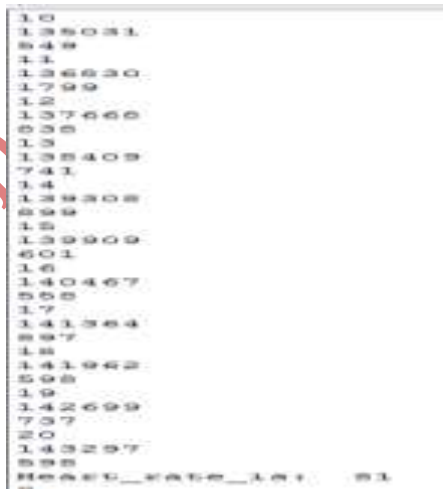

Figure2. Serial monitor display

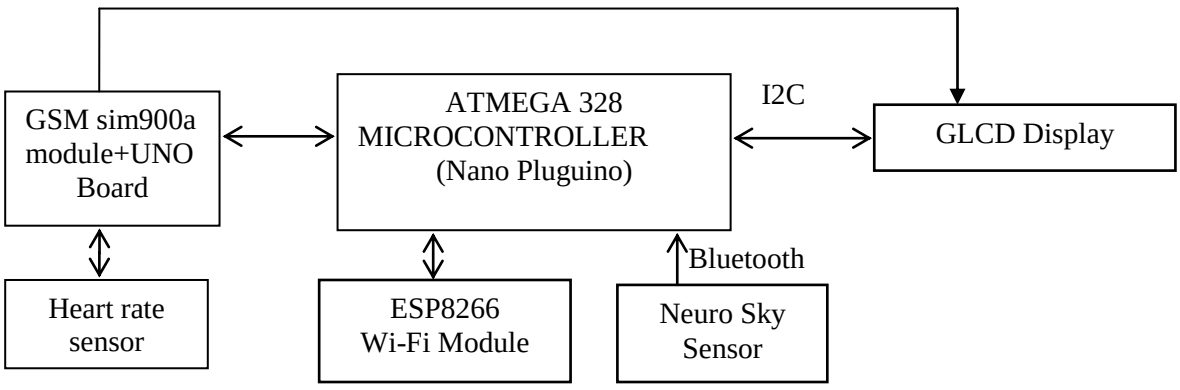

Figure1: Block diagram of the proposed system

Date_Time	Attention_level	Meditation_level	Delta_wave_value	Theta_wave_value
2016-05-02 03:06:51	87	41	18943	20126
2016-05-02 03:06:46	61	8	25148	16385
2016-05-02 03:06:42	50	35	5845	12964
2016-05-02 03:06:37	77	43	41790	6441
2016-05-02 03:06:33	43	38	1106	57951
2016-05-02 03:06:28	77	34	10910	20914
2016-05-02 03:06:24	69	4	12740	55276
2016-05-02 03:06:19	21	8	36147	15495

Figure 3. Values extracted from the NeuroskySensor

Figure 4. Heart rate and Stress level is displayed on GLCD

SDNN(ms)	**HRV Triangular Index**	**Stress Level**
25-55	2-15	Highly Tense
55-110	14-25	Slightly Tense
110-180	22-52	Mildly Calm
180-215	50-60	Quietly Relaxed
215-230	60-73	Deeply Relaxed

Table 1. Heart rate and stress level threshold values

When the parameters are fed into the system, the stress level is computed and results are given. Five different levels of Stress, i.e. highly tensed, slightly tensed, Calm, Quietly relaxed, deeply relaxed. Depending on the variation of parameters different rules were formed to suit the individualistic variations.

5. SIMULATION RESULTS

In Arduino based system, the execution speed can be measured by timer function included in Arduino. Figure 5 shows the result of the heart rate. The advantage of the Arduino also is be able to generate the output almost instantly.

Figure 5. Output shown in PC monitor

6. CONCLUSION

Stress detection system can help people to manage their stress level especially the person who suffer the episodic and chronic stress. The use of neuro sky sensor enables to detect brain waves, it can captured the

signals from the real time information on the person by using Arduino Mega board. As a conclusion, based on the results obtained from the project, a prototype of stress detector has been successfully developed. It showed that the project achieved the proposed objective. The signals measured by the stress detection system on the state of mind of the human contain real time information. Apart from that, the prototype is designed to use low cost equipment and create a real time application.

In addition, Arduino Atmega 328 microcontroller is portable, affordable and easier used can help to implement such system in real time application. The visual output also make the system look useful and the important is more attractive. People can handle it to manage their stress level with understand what stressor cause the stress problem by creating a stand-alone stress detector.

7. ACKNOWLEDGMENTS

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